EPA GRANT: Protecting Watersheds, Water Quality and Aquatic Resources from the Impacts of Growth, FFY 2010

TITLE: Protecting Puget Sound Watersheds from Agricultural Runoff Using a Progressive Manure Application Risk Management (ARM) System

WATERSHED TO BE ADDRESSED

This project will address sections of the Nooksack (17110004) and Strait of Georgia (17110002) Watersheds located in Whatcom County, WA. The combined land area to be addressed is approximately 310 mi^2.

GRANTEE CONTACT INFORMATION

Grantee:
Whatcom Conservation District
6975 Hannegan Rd.
Lynden, WA 98264

Contact Person:
Nichole M. Embertson, Ph.D.
Project Manager, Lead Scientist
Sustainable Livestock Production Program
P: (360) 354-2035 ext 126, E: nembertson@whatcomcd.org.

TOTAL FEDERAL FUNDS REQUESTED

$ 710,887

TOTAL NON-FEDERAL MATCH (33%)

$ 237,563 (33.4%)

ABSTRACT

Urban growth and land use changes are forcing agricultural operations to farm high risk lands and threaten an increase in pollution events to an already impacted watershed. Agricultural manure application to farm fields is considered a primary contributor of fecal coliform and nutrient loading to waterways and also contributes nitrogen via atmospheric deposition from manural ammonia emissions. Utilizing the current guidelines for manure application will not decrease runoff contamination below desired thresholds. We propose a new Application Risk Management (ARM) System that presents an innovative way to evaluate agricultural land use designations and subsequent application risk for individual fields using soil and weather parameters to reduce seasonal surface water, groundwater, and air pollution events. Coupled with new technologies to help educate and inform farmers, this new system promises to reduce runoff events and significantly reduce the amount of agricultural pollution that reaches groundwater, salmonid rivers, shellfish beds, and the airshed.

RESTRICTION ON ASSOCIATION WITH ACORN

The Whatcom Conservation District is **not** an affiliate, subsidiary, or an allied organization of Association of Community Organizations for Reform Now (ACORN).

1. DESCRIPTION AND SIGNIFICANCE OF THE WATERSHED

This project will address two adjacent watersheds located in western Whatcom County, Washington: the Nooksack (17110004) and the Strait of Georgia (17110002) (*see **Nooksack and Strait of Georgia Watersheds** map attached*). These two watersheds encompass 1,687 mi^2 bordered by the Cascade Mountain Range to the east, Canada to the north, and the Pacific Ocean to the east. Within these two main watersheds are smaller watershed areas including the Lower Nooksack Sub-basin (Nooksack), as well as Drayton Harbor, Birch Bay, and Lummi Bay (Strait of Georgia). Each of these watersheds has surface waters that flow from inland areas to the marine, affecting the Puget Sound, as well as various resources, communities, and industries along the way. Collectively, the health of the two watersheds is under great pressure from land use changes and agricultural uses.

The Nooksack Watershed. The Nooksack Watershed is a 776 mi^2 basin that extends across the western portion of Whatcom County from the Cascade Mountain Range to the Pacific Ocean (s*ee map*). We are addressing an area of approximately 212 mi^2, which comprises the Lower Nooksack and part of the South Fork Sub-basins. This is a very productive area, home to an estimated 30,000 people and approximately 148,027 acres of farmland with a market value of over $326 million per year. The majority of that market value (57%) comes from the 40,000 dairy animals located in Whatcom County, 30,000 of which are in the Nooksack Watershed. Weather and land characteristics in the area are ideal for dairy production and have propelled Washington State to #1 in per cow milk production in the US. The great majority of dairy operations in the Watershed are located on tributary ditches, creeks, and streams that feed the Nooksack River, which is the major watercourse running through the heart of the Basin. The Nooksack River is unique in that it the main run for many threatened or endangered fish species including native Pacific salmonid species (Chinook, Coho, Steelhead, Sockeye, Cutthroat, Dolly Varden and Bull trout). It is also the primary fresh water source feeding Lummi and Portage Bays, productive Tribal shellfish areas. Additionally, a great portion (~65%) of the forest and wetland areas that once provided habitat and water treatment in the watershed area have been converted to agricultural lands, but a portion still remain undeveloped. These areas along with natural forested and marine areas provide important habitat for migratory and native waterfowl, birds, and raptors.

The Strait of Georgia Watershed. The Strait of Georgia Watershed is a 911 mi^2 coastal basin that extends the length of the Strait of Georgia from the Canadian boarder to the Puget Sound. We are addressing an area of approximately 98 mi^2 within the Drayton Harbor and Lummi Bay Watersheds (*see map*). The area is home to approximately 11,000 people and hosts diverse land uses. The Drayton Harbor watershed is also home to over 5,000 dairy animals, most of which are located adjacent to Dakota and California Creeks, both of which flow into Drayton Harbor and Birch Bay, Nooksack Tribal, recreational, and industrial shellfish producing areas. With over 155 miles of marine shoreline, the watershed is home to a variety of costal and marine waterfowl species.

Collectively, the Nooksack and Strait of Georgia watersheds contain a host of important natural resources, thriving communities, and lucrative agricultural industries. Tribal groups in the watersheds (Lummi and Nooksack Tribes) rely on the shellfish and salmon resources present in the watersheds for both cultural customs and revenue; communities rely on clean water and clean air; and agriculture relies on productive lands and adequate space to farm. Historically, the watersheds have had a great level of productivity, but increasing growth pressures and environmental pollution is threatening the future of all populations, animal, human and plant, within the watersheds.

2. THREATS AND EMERGING PROBLEMS

The combined Nooksack and Strait of Georgia watershed areas outlined above are under both land use change and environmental resource pollution strain. The primary resources and industries affected by

these pressures are agriculture (primarily dairy), shellfish and salmonid fish populations, as well as the water and air quality that supports these industries and the populations that surround them.

Due to land use changes and population pressures, the Lower Nooksack Sub-basin has a heavily impacted floodplain, high nitrates in groundwater, and poor riparian conditions throughout the Nooksack River and most of its tributaries. Dept. of Ecology's (DOE) current 303(d) list of impaired waters shows that there are 34 streams and rivers in the watershed that are above acceptable limits for, among other things, fecal coliform, the primary source of which is estimated to be the improper application of manure to agricultural fields. Poor water quality, coupled with the loss of stream habitat, has contributed to the noticeable decrease in annual salmon populations returning to the watershed. This impacts Tribal communities as well as local industries, and threatens the future health of the salmon population in the area. Additionally, compared to other rivers in the Puget Sound region, the Nooksack River near its mouth at Portage Bay has among the highest levels of nitrogen, phosphorous, and suspended solids, which affects both upstream fish and shellfish populations. This is due in part to the large number of agricultural operations located upstream in the Nooksack Sub-basin.

As the polluted rivers and streams discharge into the Sound, they directly affect bays and shellfish growing areas. California and Dakota Creek and the Nooksack River dictate much of the water quality and health of the Drayton Harbor and Portage Bay shellfish industries, respectfully. The shellfish beds in both areas are Tribal and the Nooksack and Lummi Nation both have an economic and cultural stake in the continued health of these beds. During dry weather, bacterial contamination in the shellfish beds is not an immediate concern, but during storm events, a clear threat of nutrient and bacterial pollution still exists from upland land uses. The Portage Bay Shellfish growing area, which was closed due to fecal coliform contamination in the late 1990s, has been re-classification to open status due to an EPA success story that targeted nutrient mitigation strategies for dairy operations (Nutrient Management Plans) to reduce fecal coliform in runoff. Unfortunately, this success story is in jeopardy of relapse into failure if further action is not taken. While most of Portage Bay is open for shellfish, only a small portion of the Drayton Harbor shellfish growing area is open for commercial harvest. There are still restrictions in Drayton Harbor depending on rainfall, and if more than a half-inch of rain falls in a 24-hour period, the beds will be closed immediately for five days, a common occurrence in the watershed. A large portion of the Harbor is still under prohibited status, which contributes to a huge annual economic loss. The Lummi Nation estimates that historical closures of 150 acres in Portage Bay have resulted in a financial loss to the Tribe of approximately $250,000 annually.

In addition to water quality, air quality is also adversely impacted by growth and improper land use. Urbanization leads to an increase in fuel use and urban emissions, which when combined with natural VOC production from vegetation and agricultural ammonia emissions (which are not currently addressed nor regulated), can increase the production of fine particulate matter (PM2.5) and smog. This fine PM can adversely affect human health and deposit via rain or dry deposition on inland waterways and on the Sound, increasing nutrient loads and decreasing water quality. A reduction in agricultural ammonia production, up to half of which comes from field manure application, may aid in reducing smog and PM deposition within the Puget Sound airshed. Urbanization can also increase greenhouse gas production and subsequent climate change issues in the region via the conversion of productive agricultural and forested lands to impervious urban surfaces, which decreases vegetative carbon sequestration. Climate change coupled with population growth has put a strain on already scarce and diminishing water resources available for municipal and ag irrigation use in the watershed.

With population growth expected to increase by 22% over the next 15 years within the watershed areas, it is vital to identify the resources and community populations that will be most impacted by growth. It is estimated the majority of growth is expected to occur in unincorporated areas and on the outer limits of city boundaries, land that is currently in native vegetation or agricultural production. With over 148,000 acres currently in use by agricultural production (37,000 used for dairy production),

and only 85,000 actually zoned for agriculture (a large portion of which is high risk; *see* ***Agricultural Land Use Risk Ratings*** *map*), un-zoned, low risk ag lands will likely be the areas that will yield to population growth. Unfortunately, there is a limited amount of ag land available with limited water pollution potential, and it is typically taken by industries that can pay high dollar, such as specialty crop or berry farmers, not dairy farmers. The remaining land available, which is prone to flooding and saturation, is more often being used by dairy operations for hay and corn production. However, it is also these characteristics that cause an increase in potential runoff and water pollution issues, mostly from the increased concentration and the improper timing of application of manure to farm fields. Without addressing the risk factors and management decisions associated with manure application, urbanization may exacerbate current pollution problems, not resolve them. Additionally, with an increase in possible urban pollution sources to the watershed (septic tanks, wastewater treatment, residential runoff, pets, etc.), the agricultural sector has a lower threshold of pollution toleration than ever. Impacts from improper manure application practices are reflected in many of the resources within the watershed such as water quality, salmon populations, and shellfish habitat areas, and tolerance is diminishing. Land use changes and subsequent environmental pressures put on agricultural producers are driving them out of the very communities that have been built on agriculture. This is a determent to Whatcom County, which prides itself on local food and sustainable communities.

In Whatcom County, as in many other counties in the State, impacted and poorly managed agriculture (in particular, manure application by dairies) has repeatedly been identified as a leading contributor to air and water pollution in the watersheds. Therefore, the most productive way to address many of the water and air pollution issues within the watershed and contribute to the larger interconnected effort of protection of the watershed is to target the proper application of manure to farm fields. Improper application of manure can lead to runoff, which can cause low dissolved oxygen, algae production, high nitrates, and pathogens in water. Since dairies are the largest producers of manure and manure application in the watershed, improvements in field application methods and timing are necessary in order to protect important watershed and air resources from further negative impacts. However, current guidelines do not promote better application practices, and in fact, threaten the health of the Sound even further by pushing application under risky conditions and times of the year (October and March) without proper assessment of weather or field conditions. Currently, the ceasing of manure application in the fall is Oct. 1st in the floodplain, and Oct. 31st everywhere else; and the start date of applciation in the spring is T-Sum200 (200 cumulative celcius temperature units after Jan 1) or February 15, whichever is sooner. These application dates are problematic because they do not require farmers to assess their unique field conditions and practices; prevent application at times when it may be more faviorable; do not promote planning of dry season application; and they allow farmers to apply during unfavorable conditions contributing to both surface and groundwater pollution. The dates are estimated values chosen to coincide with the start of flood season and plant growth, but in a changing climate, are not always correct. Instead, they encourage application in the fall when uptake is diminishing and rainfall is high, and allows spring application on a date that sometimes encourages application during wet conditions and when water tables are high. We can see a correlation between late season manure application, fall rainfall events and most shellfish bed closures and salmon migration events. Additionally, we see an increase in dry season (May-Sept) episodic air pollution events, partially contributed by ammonia from manure application during unfavorable weather conditions. This is an issue that has not been addressed in the area. Simply increasing buffer and manure setback widths is not a substitute for precision application and will not correct the root of the problem.

3. PROJECT NEED

Of the 12 Washington State Puget Sound Districts, Whatcom County has the greatest concentration of dairy cows, with 53% of the total, or over 40,000 animals, within its boundaries, most (~75%) of

which are concentrated in the 310 mi^2 of the Nooksack and Strait of Georgia watersheds. Although the number of dairy farms in Whatcom has decrease by half in the last 10 years, the number of milk cows has only been reduced by about 30%, putting increased strain on available land and water resources available. Dairying has been a pillar industry in the area for generations and is an intricate part of the community life. The dairy operations in the region have the ability to contribute in a positive way back to the environment and community by providing wildlife habitat, stream protection, carbon sequestration, and economic community stimulus. However, population growth pressures, environmental restrictions, and poor relations with environmental partners have led dairies to be identified as one of the primary contributors to water and air pollution issues in the watershed. The majority of these pollution events arise during or after the application of manure to farm fields, with water quality pollution being highest in the wet season (Oct-April) and air quality in the dry season (May-Sept). It is this area that needs to be addressed as a means of improving the health of the watershed before growth exacerbates the issues at hand.

It is the overall objective of this project to create an Application Risk Management (ARM) system that will reduce the risk of manure induced pollution within the watershed and implement a system to help farmers evaluate their application risks and monitor their progress. It will also hold them more accountable for improper application practices, as the current paradigm does not require pre-application reporting. The ARM system will supplant the current ridged application dates (Oct 31 and T-Sum200), and revise manure application setback distances and buffers to adjust with changing field and weather conditions. Instead, farmers will have to cease fall application in September and have limited early season application, which has been shown to be beneficial to plant growth and nutrient uptake during the spring. This will prevent application in risky times and support application at times when it is appropriate and poses the least threat to resources. When properly implemented, the system will be successful in contributing to the goals of our local WRIA 1 partners, as well as EPA national goals for Puget Sound, by improving the health of 37,000 acres of impacted farmland, 350 miles of impaired waterways, and 7,000 acres of shellfish growing areas. It will also address the priorities of the Puget Sound Action Agenda by reducing a source of water pollution in the watershed and protecting from it future pollution with education and good management tools. The impact of these achievements should help keep shellfish beds open during high risk seasons, reopen prohibited areas, reduce fish barring stream pollution to increase the health of the salmon, and sustain agriculture and the rural lifestyle in a growing community. Since water and air act in a symbiotic relationship, typically trading impacts like a see-saw, the ARM system will be addressing the air quality and climate change within the 300 mi^2 airshed to make sure we are not trading one problem for another, but rather addressing both equally. This addresses EPAs clean air and clean water priorities by eliminating sources of airborne deposition of nutrients (nitrogen) on waterways.

Since the other dairy producing districts in the Puget Sound share our same environmental issues, this system will be widely shared with others to decrease the impacts of agricultural pollution beyond Whatcom County. It is our intention to adapt and share this system with other Conservation Districts and livestock management organizations in Washington State and the Region, as well as our partners in Canada, all who share some or all of the same resource concerns as we do. The ARM system idea has been met with positive response from farmers, regulators, Tribes, and community members. Additionally, OnePlan software developers have expressed interest in its integration into their nutrient planning software programs, and it can also be used with other tools like Manure Management Planner (MMP). Overall, the ARM system should provide a way for farmers to evaluate their air and water pollution risks associated with manure application at any time of the year and apply with greater precision, flexibility, and responsibility, which should increase yields, decrease environmental pollution, and restore a sense of environmental stewardship. To date, there are no similar application management systems in use.

Project Objectives based on the Framework for Watershed Planning:

1. Conduct a series of land surveys to identify areas within the watershed that are at high risk for ground and surface water pollution, as well as classify low risk areas that are best suited for agricultural land use.
2. Create an interactive Application Risk Management (ARM) System that minimizes field runoff possibilities during the wet, flood prone seasons and reduces the possibility of airborne emissions during the dry season using a combination of field risk analysis, comprehensive runoff and volatilization best management practices (BMP), better monitoring of application, and increased responsibility to farmers.
3. Adapt current NRCS vegetative practices and manure setback distance guidelines to be more seasonally appropriate and effective for managing potential runoff from fields.
4. Collaborate with project partners and farmers in addressing the needs and concerns of all state, local, and producer participants, while also creating and recommending management policy actions for nutrient and fecal coliform management through good manure application practices.
5. Integrate the ARM system into planning software and Nutrient Management Plans at a County and State wide level.
6. Evaluate success with ongoing monitoring of both test and control sites for waterborne fecal coliform and nutrient (N and P) levels and airborne ammonia and GHG levels on a regular basis.
7. Develop educational and informational materials that will be available to all producers and custom manure applicators including a workshop, webpage, newsletter, and email/fax alerts. These materials will help manure applicators learn about the program, get help, and keep informed on times when application is optimal or prohibited.

The long-term outcomes of this project are the implementation of more comprehensive and effective manure application management system that will reduce runoff and air pollution events, decrease the fecal coliform and nutrient loading into the Nooksack and Strait of Georgia Watersheds, and increase the vitality of freshwater fish and marine shellfish areas, increase surface and groundwater quality, and improve air resources for the community. Additionally, by giving farmers a more active and responsible role in the management of their land, we hope to reinvigorate the sense of environmental stewardship that was once prevalent in this area and reconnect farming to the community.

4. PROJECT PLAN AND COMPONENTS

This study will develop an innovative and much needed manure Application Risk Management system that will decrease the number of runoff events, thus reducing the amount of fecal coliform, nutrients, and sediment that reaches surface waters. The study will be conducted in 4 phases in sync with the Framework for Watershed Planning, 1) Assessment, 2) Development, 3) Implementation and Monitoring, and 5) Evaluation, Adaptation, and Outreach over four years. Refer to the Logic Model for a breakdown of individual Phase outputs, outcomes, and timeline of activities.

Phase 1: Assessment. Phase 1 is the characterization and assessment of the watershed as it relates to agricultural practices and potential environmental impacts. Using a system similar to the Birch Bay Watershed Classification model, we will work with our partners at the Department of Ecology (DOE) to rate areas from high to low risk within the watershed using an “Index of Process Condition” based on 15 different risk factors (soil type, permeability rate, seasonal high water table, distance to surface water, slope, hydrologic group, available water holding capacity, drainage rate, flooding potential, ponding potential, compaction potential, runoff rate, aquifer recharge, wetlands present, and crop type) relating to ground and surface water pollution potential. Information on risk factors will be obtained by GIS mapping, soil surveys, and visual surveys (when necessary). Once areas are classified, we will use GIS technology to create watershed maps of each of the 15 layers as well as a comprehensive map

identifying the overall risk ratings throughout the watershed (*see **Agricultural Land Use Risk Ratings** map for example*). By identifying "hot spots" within the watershed, we can identify areas that will benefit most from application risk management. This land survey will also locate areas that are best suited for agriculture, aid in land use planning for environmental protection, and help farmers make better land use decisions such as on crop selection and manure application technologies based on their unique location and soil characteristics. This same process will also be used on a micro scale with individual farms to assess the risk level associated with manure application to specific farm fields and identify problem spots.

Assessment of our famer audience is pertinent to success of information delivery. To better identify the most effective modes of communication, producer preferences, appealing incentives, knowledge base, and current practices, a survey will be sent out (mail and web based) to all producers in the watershed areas. The survey will be created to take no more that 15 minutes to complete, and since it will be sent to over 10 people (approximately 120), it will go through OMB for approval. The survey will be analyzed for preferences and trends to give us an idea of target outreach areas and information delivery systems.

Phase 1 Deliverables

- Land survey and risk rating index for watersheds.
- Individual land risk evaluations for project farms as they are enrolled.

Survey of dairy producers in the watershed to gain a better understanding of current practices, constraints to environmental mitigation, preferences for manure management, and knowledge base.

Phase 2: Development. Phase 2 is the development of the innovative Application Risk Management (ARM) System to address both water and air quality impacts associated with manure application. The ARM system is based on two main factors, a farm field risk evaluation conducted by WCD (*see Phase 1*) and the use of a web based risk management worksheet designed to help a producer determine what appropriate application rates are, as well as the application risk index for that current time of year for water and/or air quality.

Once a farmers fields have been given a risk rating based on analytical and visual criteria, only fields that are medium risk or lower will be considered for application during high risk times (October-March). Prior to application of manure to any field, any time of the year, a producer will need to complete an ARM worksheet, which will evaluate both runoff and volatilization potential and provide feedback for proper application techniques. The worksheet will require farmers to evaluate their impact potential (i.e., distance to resources, emissions, groundwater recharge, etc.), current field conditions (i.e., ponding/flooding, frozen ground, soil moisture, water table depth, vegetation density and height, buffers, etc.), application method, and current and forecasted weather conditions. All of these parameters, along with soil type and nutrient analysis results, will then be entered into an interactive worksheet and a pollution risk rating will be calculated using specific criteria along with practice guidelines and a maximum recommended application amount. If conditions are not optimal for application (i.e. water table too high, significant rain in 3 day forecast, low crop uptake, etc.), the system will tell producers to wait to apply. This complex type of feedback will require the creation of detailed background calculations based on both modeled and field proven values for each of the criteria, as well as comprehensive parameter definitions and feedback responses. Additionally, we will be partnering with Agriculture and Agri-Food Canada to adapt, validate, and integrate their air quality prediction model into the ARM system. Their model gives information on real time and projected soil and reactive nitrogen constituents in a gauge style format. This information will be used to predict how different methods and timing of application can effect air quality and crop yields. Using a web design consultant, all of these functions will be integrated into a user-friendly on-line tool that will give automatic feedback on input values, as well as capture and log the data for our records and analysis.

The worksheet will allow producers to responsibly evaluate each of their fields on a seasonal basis and only apply an appropriate amount of manure to fields that are at low risk for environmental pollution.

To ensure producers have done the calculations to evaluate their application risks, an accountability system will be implemented where producers will have to submit their analysis sheet to WCD prior to application for approval. This level of "supervision" is vital during the high runoff seasons. An emergency response protocol will be in place in the unlikely event that any of the test farms has a discharge while following project guidelines. This response protocol, as well as a monitoring and management system, will be developed and implemented with our partners at DOE and the Washington Department of Agriculture (WSDA) to make sure producers follow the system guidelines and enforce appropriate action when they do not. If a producer deviates from the system, a penalty protocol will be instituted.

In addition to the ARM worksheet, seasonal manure application setback distances and dates, and vegetative filter strip widths and practices, will be reviewed and revised as necessary with our partners at NRCS to maximize their effectiveness, while also allowing appropriate maximum use of field area. This will be accomplished by developing a practice decision tree that helps guide planners and producers to the correct vegetative practice combination based on their management and field characteristics. The effectiveness of these types of "insurance" practices will be compared against precision application practices with controlled field trials set up in a block design.

To ensure that we are creating a useful, efficient product, a two tiered technical workgroup will be assembled consisting of a farmer panel (tier 1) and partner workgroup (tier 2) (*see Partnering for identification of partner groups*). The group will be anchored by progressive and cooperative dairy producers who are willing to offer constructive criticism to the ARM System and its components as well as communicate its efficacy to fellow dairymen. Individual dairy producers will be solicited for their participation in the group and some panel meetings will correlate with the local chapter dairy meeting to ensure a broader participation by dairymen throughout the area. In addition to their individual contributions to project components, project partners will offer input to the process to make sure we are meeting common goals and collaborating in a productive manner. Partner meetings will largely be conducted on an individual basis to present the ARM system and receive feedback, but one larger workgroup meeting will be held once every two years that brings together farmers and partners. Meetings will be held bi-annually for the farmer panel (8 total) and annually for partners (4 total including individual meetings). Establishment of a cooperative working relationship between the two groups will foster a long-term productive and successful environment in the watershed.

In addition to the ARM worksheet, new risk management technologies will be developed. These technologies include application alerts posted on our website as well as sent via text messaging, email, or fax. A webpage, linked to the WCD website, will be developed in-house with local weather forecasts, worksheet Q&A, application techniques, vegetative maintenance guide, etc., to provide farmers with information relevant to application and the ARM system. Lastly, a self-update system will be developed with partners at OnePlan or MMP for farmers to self update on a yearly basis to adjust application levels when appropriate (i.e., if crops, fields, or manure chemistry changes). This self update system will allow farmers to update on a yearly basis, instead of having to wait up to 5 years for a plan update, thus allowing them to more precisely manage their nutrients.

Phase 2 Deliverables

- ARM Worksheet.
- Develop an accountability system including an emergency response plan and monitoring and enforcement plan.
- Revise current manure setback distance and buffer guidelines and develop a decision tree for selection of optimal practices for the protection of resources.

- Assembly of workgroups including the farmer panel and partner groups.
- Development of tools: Application alerts, webpage, self-update system.

Phase 3: Implementation and Monitoring. Once the ARM system has been developed, it will be implemented, tested, and monitored for success. This Phase will extend over three application seasons. The first year (2010-2011), we will test the ARM system on a total of 10 dairy farms who have already given their commitment to participate in the project and provide feedback. We kept this number to 10 to insure we can provide a high level of observation, management, and guidance in the infancy of the system. The farms chosen vary in risk rating and location within the watershed, which illustrates the different characteristics of the watershed areas. Test farms will have both control (following current application guidelines) and trial fields (ARM system) to evaluate the effectiveness (water quality, yields, etc.) of the system in a relatively controlled setting. Each successive year, we will add at least 10 new test farms to the project until a proposed total of at least 40 test farms are participating in the project throughout both watersheds. Every farm that participates in the study will receive a Nutrient Management Plan update, as well as detailed mapping of fields, waterways, and identification of sample locations associated with a sample plan. In addition to application volume and frequency, we will look at how different application technologies (i.e., big gun sprinkler, aerator, splash plate, injector, etc.) affect the system, as well as manure type (liquid or solid) and consistency (thick to thin). Based on this information we will develop manure application best management practice (BMP) guidelines for joint water and air pollution reduction with our partners at NRCS. We will work with NRCS and our partners at other CD's to have these BMPs approved and installed over all of Western Washington.

ARM worksheet outputs and subsequent application records will be kept to track the feedback mechanism of the system as well as map the nutrient loading to areas in relation to stream pollution levels and air emission events using GIS software. This will help us revise, adapt, and track the validity of the system, as well as assess the impact of ag-urban growth pressures and possible impacts.

To measure the effectiveness of the ARM system, comprehensive soil, surface water, groundwater, and manure testing of nutrient and FC levels from each project test site will be conducted throughout the year. Measurements will be taken in the field as well as upstream and downstream of test areas to determine any pollutant contribution to surface waters from test fields. In conjunction, monthly data provided from static water quality monitoring stations (monitored by Whatcom County Public Works and DOE, and analyzed by Northwest Indian College) will be utilized to conduct a broader monitoring campaign throughout the watershed with partners at Lummi Nation and WRIA 1 to monitor the long range impact of the project. Ambient air quality measurements will also be taken for ammonia and greenhouse gases (nitrous oxide and methane). All of these measurements will be used in the validation of the system, tuning of worksheet parameters, and assessment of the watershed. Additionally, qualifying environmental data will be entered into STORET.

A more detailed explanation of measurements is located in the Monitoring and Measuring section as well as the QA/QC plan.

Phase 3 Deliverables

- Identification of test farms, update of NMP, field mapping and risk analysis, and implementation of ARM system.
- Monitoring, assessment, and validation of ARM system implementation via soil, surface water, groundwater, manure, and air sampling.
- Mapping of nutrient loading in relation to stream pollution levels and air emission events.

- Analysis of application technologies and characteristics to aid in development of manure application BMPs for water and air pollution reduction.

Phase 4: Evaluation, Adaptation, and Outreach. A constant evaluation and revision of the ARM system will be conducted as results are obtained and input is received from producers (users) and project partners (evaluators). This will ensure that the system and its tools are user friendly, comprehensive, and successful at achieving the desired watershed protection goals.

To ensure the long-term success of the ARM system, all Nutrient Management Plans created or updated by WCD will include the ARM system. In addition, cost-share incentives will be explored with partners at NRCS to identify sources of funding for farmers implementing the ARM system with more rigorous conservation practices. Additionally, guidelines for manure application dates, setbacks, and restrictions will be revised to reflect our findings and more stringent guidelines. In conjunction, legislation will be explored to support our guidelines and aid in implementation of the ARM system on a larger scale. This endeavor will need to be explored through partners at the Dairy Federation, DOE, and EPA. One of our long range goals is to adapt the ARM system to apply to all forms of agriculture that graze or apply manure including berry and crop farmers, small farms, hobby farms, mitigation projects, and other livestock (poultry, beef, swine). Currently, none of these sectors are regulated and/or monitored for application.

Partners involved in the project will also be a part of the success of the project by helping to support, monitor, implement, and educate people about the program. A public outreach effort will be initiated to inform and gain support from the public, who are typically the ones reporting manure misuse events. A workshop, web link, newsletter, email/fax alert system, and development of new technologies will aid in keeping producers and the community involved and informed on the systems success and benefits. The workshop will be conducted near the end of the project to inform people of the ARM system, guide them through its proper use, and address any questions. The target audience will be ARM users including farmers, custom manure applicators, and NMP planners, but partners wanting to know more about the system will also be invited. The newsletter will be developed in the first two quarters of the project and sent out quarterly thereafter. The newsletter will address various environmental issues related to dairy farming and manure/nutrient management, as well as latest BMP technologies, mitigation practices, and up to date pertinent information on issues.

At the conclusion of the project (2014), a final project report will evaluate the system with scientific basis and determine its sustainability and effectiveness at achieving a permanent reduction of fecal coliform and nutrient levels in rivers and bays as contributed by runoff from agricultural fields. In practice, the system should be successful in protecting 37,000 acres of farmland, 350 miles of surface waters, and 3,000 acres of shellfish areas.

A timeline of the tasks and activities (outputs) to be completed within each Phase of the project is located in the Logic Model, with a more detailed timeline by quarter presented in Timeline and Milestones.

Phase 4 Deliverables

- Continuous evaluation and adaptation of ARM system based on project results and user feedback.
- Explore cost share incentives, revise manure application dates throughout the District, explore legislation through partners to incentivize ARM system and adapt the ARM system to include all form of agriculture the utilize grazing or manure application practices.
- Outreach activities including a newsletter, email list, and workshop to educate users about the ARM system and related environmental issues.

- Quarterly reporting throughout project and final report at conclusion.

5. PARTNERING

Partnership and collaboration is vital part of a successful project. In order to make sure we produce a comprehensive, environmentally protective, and yet user friendly product, we will engage government, environmental, scientific, and producer partners. Each partner listed below contributes to a vital part of the information and expertise needed to create a system with integrity and longevity.

Dairy Farmers – One of the most important partners for the success of the ARM system is the agricultural community. In addition to all of the dairy producers participating in the testing and evaluation of the system, a Farmer Panel will be created that is composed of dairy producers within the two targeted watershed areas. We will recruit progressive and adaptive producers that are willing to donate their time and knowledge to the project. The panel will be composed of 10+ producers, whose task will be to review and constructively criticize the system and its components, making sure we create a product that farmers will be sure to use with ease.

A Partner Group will also be assembled whose task will be to offer feedback and policy assessment of the system. Representatives from each of the following agencies have offered in-kind time donations to participate in various aspects of the project. **Washington Dairy Federation** – Help support our efforts within the dairy community and provide contacts and communication outlets (i.e., meetings, newsletters, mails, etc.). **Washington Department of Agriculture (WSDA)** – Work in close partnership with ARM enforcement and support. **Department of Ecology (DOE)** – Collaborate on "Index of Process Condition" for agricultural lands in Whatcom County. Work in close partnership with ARM enforcement in watershed. **Natural Resource Conservation Service (NRCS)** – BMP development, cost incentive program development. **Whatcom County Public Works, Drayton Harbor Shellfish Protection District Advisory Committee** – Offer feedback and support of project efforts. **Agriculture and Agri-Food Canada**– Work with Shabtai Bittman on air quality monitoring and air quality section of ARM worksheet. **NRCS** – Create and initiate new BMPs, incentive programs, and dissemination of ARM system. **Western Washington University** – Water sampling. **Lummi Nation** – Partner of water quality sampling and monitoring. **Washington Conservation Commission** – Partner with sister Districts to implement ARM system on a State wide scale. **EPA** – Work with our partners at EPA to integrate ARM system into applicable tools and policy. Others - **Portage Bay Shellfish Protection District**, **Ag Advisory Council**, **Farm Friends**, and Whatcom County community as a whole.

6. ANTICIPATED OUTPUTS AND OUTCOMES

The overreaching environmental objectives of the project are 1) the near elimination of seasonal fecal coliform and nutrient loss from 37,000 acres of manure applied dairy farm fields to the 350 miles of surface waters in the Strait of Georgia and Nooksack watersheds, and the reduction of possible groundwater contamination (nitrates) contributed by improper manure application on those acres, 2) a significant increase in the quality of water that reaches the 3,000 acres of oceanic shellfish growing areas currently affected by poor water quality, 3) a decrease in manure related episodic air pollution events ($PM_{2.5}$) in the airshed that can effect human health and increase nitrogen deposition on waterways, and 4) a renewed sense of environmental stewardship in the agricultural community. Please refer to our Logic Model for more detailed outputs (activities and deliverables) and outcomes by project Phase (*attached*).

7. MONITORING AND MEASURING

In order to evaluate the efficacy of the ARM system, all test sites will be monitored for runoff, and manure, soil, water, and air constituents measured for the entirety of the project. Currently, there are DOE and WRIA 1 stationary monitoring sites along most of the major waterways located in the watersheds as well as at the mouth of the rivers at shellfish production areas. These monitoring stations will be monitored on a consistent basis to provide information on background temperature, FC, and DO, levels as applicable, variability, and pollution spikes to help us locate problem areas and times. A detailed statistical analysis of test and control farm areas will also be established in order to measure the ARM system directly. In order to accomplish this, each farm field will have soil and manure samples taken on a regular basis (see details below), as well as samples from adjacent waterways. A sample from each waterway located on or near a test field will be collected upstream (background), and downstream (source pollution) of the farm field using a paired t-test model. The difference of the two measures is the pollution directly contributed by that field. Water quality samples will be taken for periods before and after field application, as well as randomly once weekly during high runoff seasons (October-April), and once every two weeks the rest of the year. During big storm events, additional samples will be taken. Groundwater samples will be taken on test and control fields using a variable tube technique. Soil samples will be obtained using a random sampling grid method before each manure application and one week after to evaluate agronomic application rates. Manure samples will be taken at each application. Crop yield data will be taken and compared between test and control fields to assess system benefits. All sample data will be analyzed using statistical models to evaluate significance (alpha level of 0.05) within test sites and between test and control sites.

Water samples will be analyzed by a DOE accredited laboratory for fecal coliform, TKN and total-P using standardized methods. Dissolved oxygen, pH, and temperature will be taken with a sample probe. Soil and manure samples will be analyzed for fecal coliform, total-N, total-P, and pH using standardized methods. We will follow our QA/QC project plan for all sample handling and analysis.

Air quality parameters including ammonia and nitrous oxide, will be measured on-farm using EPA accredited equipment and methods. These measurements will be conducted in partnership with Agri-Canada. Air quality measurements will be used to establish both baseline and emission reduction target levels, as well as give the emission potentials of different land application BMPs.

Field data will be recorded at the time of sampling on a standardized form that includes monitoring information and any other observations (e.g. weather, equipment problems, and field condition) that may be important in interpreting data. All field meters will be calibrated in accordance with the manufacturers instructions and documentation provided.

A more detailed QA/QC will be provided upon receipt of the grant including detailed information on the water quality monitoring approach and laboratory protocols, including types of data and samples to be collected, sample location, sampling frequency, sampling procedures, analytical methods, quality control procedures, data handling protocols, and data assessment procedures.

8. OUTREACH AND INFORMATION TRANSFER

Upon completion of the testing and validation stage of the project, the ARM system and its components will be delivered to those individuals and agencies with similar environmental challenges that will use and benefit from it. The following outreach activities will be conducted for transfer of information:

- A workshop will be held to educated producers and custom applicators about the ARM system.
- A webpage, factsheets, revision of NRCS practices standards, and other outreach tools will be developed that can be easily accessed by producers and other users via the web or tangible means.

- The ARM system will be incorporated into all Nutrient Management Plans in Whatcom County; with distribution to small farms (i.e. beef, horse, hobby) via small farm plans desired in the future.
- Currently, we have spoken to two partner Conservation Districts (Skagit and Snohomish) within the Puget Sound area that have similar environmental challenges to Whatcom and would like to adopt the ARM system immediately upon its completion. All Districts in the State will be given the opportunity to integrate the ARM system into their NMPs.
- Creators of the OnePlan NMP tool would like to integrate the finished product into their software, which would distribute the system to a much larger audience within the Region and Nation.
- Partners will provide an opportunity to disseminate our results and lessons learned to county, state, and national agencies that will help move policy and ensure the ARM system is widely supported and implemented.
- The ARM system will be provided to our partners in Canada including Environment Canada, Fraser Valley Regional District, and Agriculture Canada, who have already expressed interest.

Since our project may have benefits to a larger agricultural sector, results will be presented to the larger scientific and regulatory community at the Georgia-Basin Puget-Sound Research Conference, National Targeted Watersheds Grantee Conference, Washington Association of Conservation Districts Annual Conference, and local and state sponsored workshops.

9. PROGRAMMATIC CAPABILITY AND PAST PERFORMANCE

The District has successfully administered federal and state grants, which included timely financial and progress reporting, communication with funding agency, and whose deliverables are always met. In addition, WCD administers grants from the Conservation Commission in four major project categories, Conservation Reserve Enhancement Program, Livestock, Puget Sound, and Implementation. These are non-competitive grants that include cost-share components, time allotment, monthly progress reports, and semi-annual and annual grant reports submitted to the Commission and/or Whatcom County. Examples of competitive grants received include (all projects had on time reporting and deliverables): **WA Department of Ecology – Tenmile Watershed Rehabilitation Phase III** – $333,333.00 (included 25% match) – Aug. 16, 2004 - Sept. 30, 2008. This project successfully provided education and support to implement Phase III of citizen-based stewardship actions to re-vegetate riparian corridors, increase environmental awareness, and facilitate behavioral changes to meet water quality and quantity goals. Water quality sampling for FC, temperature, pH and dissolved oxygen was taken monthly from Nov 2004 to Aug 2008. Data were submitted to the DOE on a quarterly basis along with progress reports on riparian planting and outreach/planning activities. All water quality data was submitted to the DOE EIM database. **WA Department of Ecology –Drainage Improvement District (DID) Education and Reform Initiative Centennial Clean Water Fund** - $331,987 (included 25% match) – Jan. 12, 2007 - Dec. 31, 2010. Project involved the production of a Drainage Creation of a management Guide specific to Whatcom County but suitable for adaptation throughout Western Washington. WCD provided education to DID commissioners and landowners through workshops and through making guidance and BMP information available on-line. The District also provided technical assistance through consultation and in-field project coordination and oversight to help guide landowners and DID commissioners in implementing drainage BMPs to meet water quality goals.

The Whatcom Conservation District is regularly recognized for its productivity, community outreach, and very knowledgeable employees. Many employees are leading experts in the field and are recruited by other Districts and State agencies to provide technical expertise on environmental and agricultural related issues. The staff outlined for this project are well suited in their roles and will help ensure that a quality product and scientifically sound data are provided. **Nichole M. Embertson,** *Project Manager & Lead Scientist,* has an M.S. and Ph.D. in Animal science with a specialty in Environmental

Management and will act as lead scientist on the project for WCD. She has participated in many State and nationally grant funded projects focused on ag-environmental planning, monitoring, and mitigation. She has participated in and/or created ag-based stakeholders groups with great success and positive response. Her scientific knowledge and statistical expertise will ensure proper sampling and analysis techniques are carried out. Nichole will be overseeing the scientific and collaborative tasks of the project including ARM creation and installment, sampling methodologies, statistical analysis, and outreach. **Dawn Bekenyi**, *Administrative Assistant*, has provided project support for all bookkeeping and administrative tasks associated with District programs for the past fourteen years. Dawn will be responsible for financial and administrative record-keeping tasks associated with this proposal. **George Boggs**, *District Manager*, has a B.S. in Agronomy and a J.D. in Law. He has managed the District since 1997 and has served on a variety of local, state, and national boards involved with policy, practices, and planning processes. He has successfully administered six Centennial Clean Water grants in the past seven years. George will provide direct oversight to District staff and direct communication with regulatory agencies to ensure timely completion of the project tasks within budget. **Chris Clark**, *Engineer in Training*, has a BS in Biological Systems Engineering with an emphasis in agricultural, soil and water engineering and has worked with Whatcom CD for over five years. Chris has written over 100 dairy nutrient management plans and has provided ongoing technical assistance to many dairies and non-commercial farms. Chris will participate as a technical resource and engineer for the project. **Andrew Phay,** *IT Specialist*, has been the GIS Technician for the WCD for seven years, since completing a B.S. degree in Environmental Planning with a minor in GIS Studies. Andrew is responsible for creating maps and other graphic materials for District projects. He also creates and maintains databases and websites for the District and for other agencies. Andrew will be providing all GIS mapping services, new technology development, and database activities.